ECMWF Future Plans: Reading, Bologna and global forecasting

Florian Pappenberger & colleagues

Director of Forecasts

@FPappenberger

ECMWF

Continuous changes to the forecasting system

Integrated Forecasting System (IFS) cycles

- Cycle 43r1:

  Upgrade to the dynamical ocean model used for the medium-range ensemble and its monthly extension, new model output (ceiling, height of convective cloud top, height of 0/1 degree wet-bulb temperature, direct solar radiation, wave energy flux magnitude/mean direction, significant wave height of all waves within a range of periods

- Cycle 43r3:

  new radiation scheme, improvement in convection, new aerosol climatology, changes in observation assimilation

- Cycle 45r1

  consistent gains in the extended range. A key plank of the upgrade is enhanced dynamic coupling between the ocean, sea ice and the atmosphere. The upgrade extends this coupling to ECMWF's medium-range high-resolution forecasts (9 km horizontal resolution)

- Cycle 46r1

  Continuous data assimilation and introduction of a 50-member Ensemble of Data Assimilations: weakly coupled data assimilation for sea-surface temperature in the tropics; improvements in the wave model, the convection scheme, the radiation scheme and the use of observations.

2016

22 Nov. **43r1**

2017

11Jul. **43r3**

2018

6 Jun. **45r1**

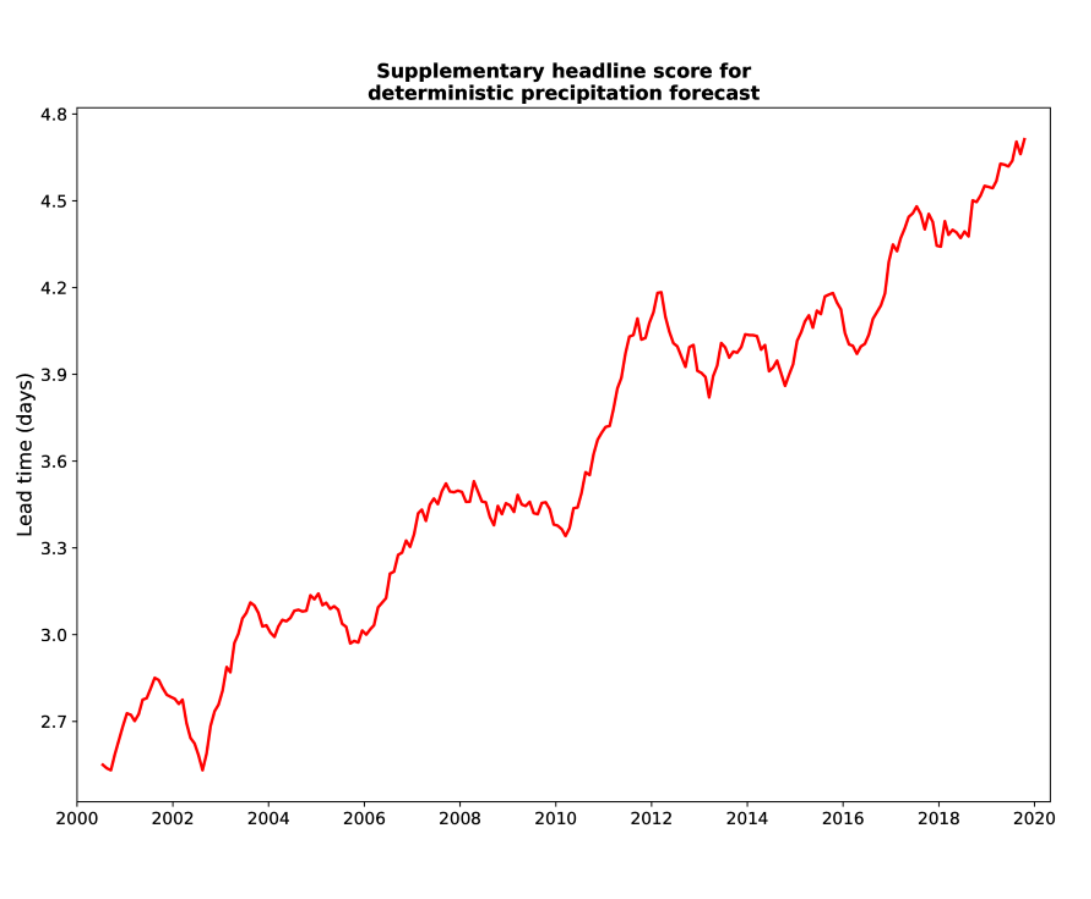
2019

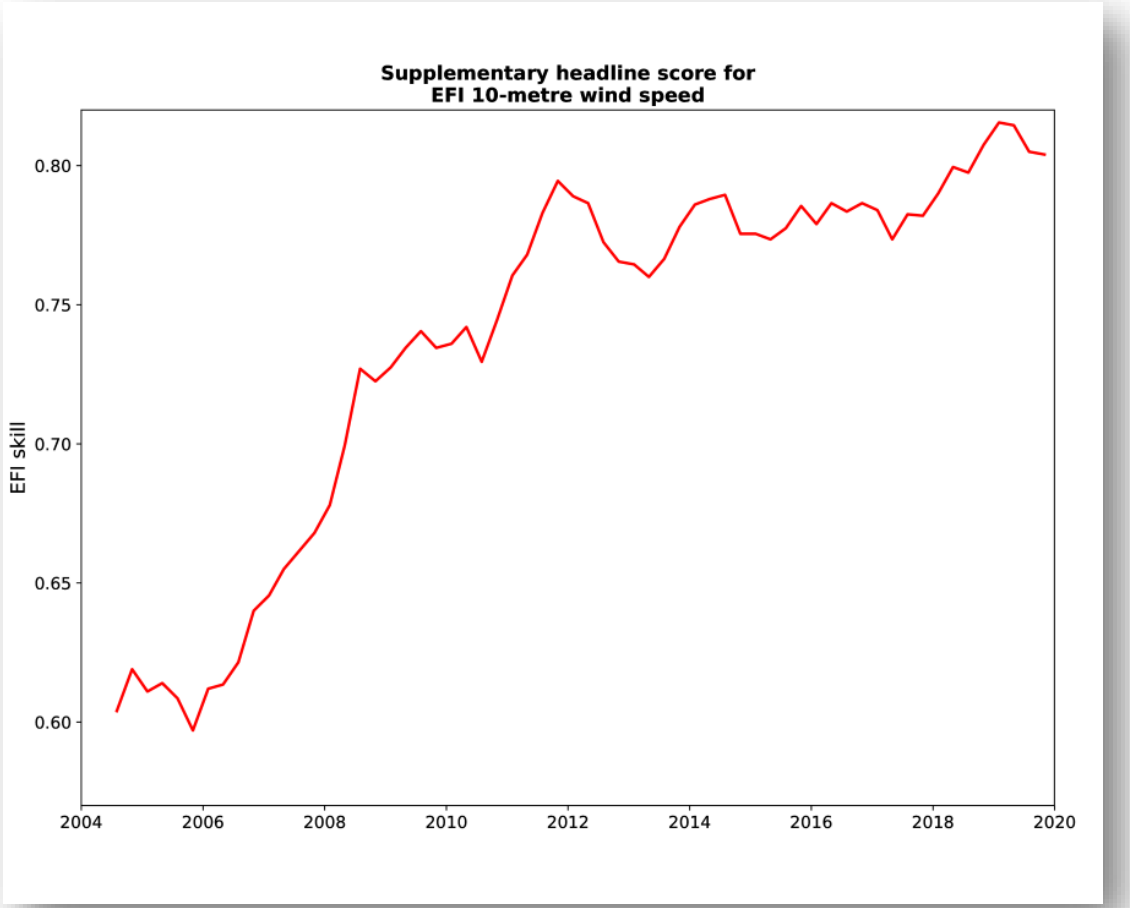
Q2 **46r1**

2020

Q2 **47r1**

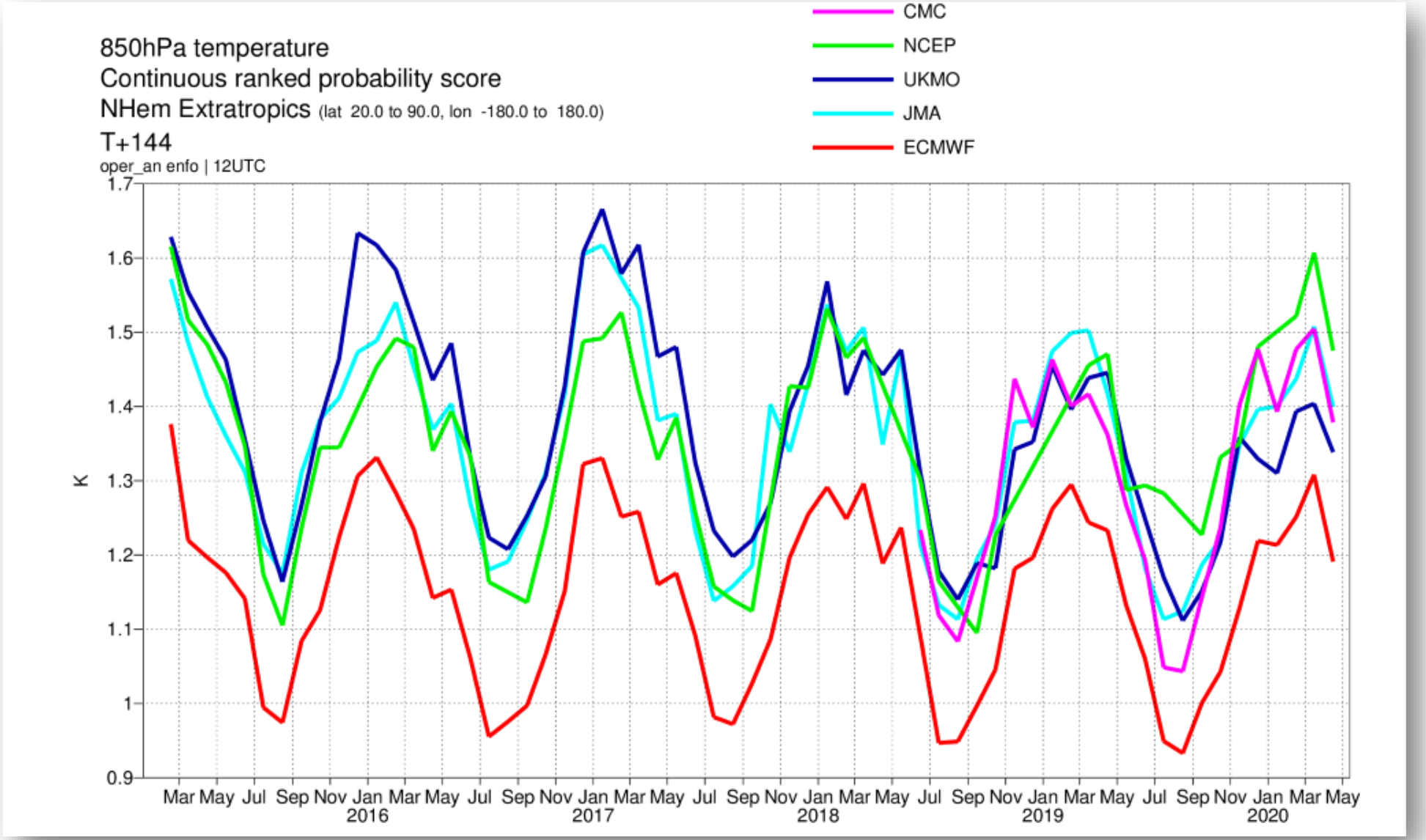
Continuous improvements of the forecast performance





Two of ECMWF's headline scores showing HRES precipitation forecast skill (left panel) and the skill of the EFI forecast for extreme wind (right panel). Both plots show 12-month running means

Forecast performance



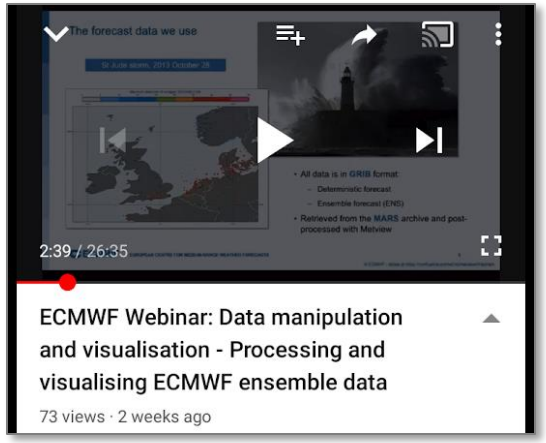
Comparison of upper-air medium-range ensemble forecast skill of different global models based on the TIGGE dataset. Shown is the continuous ranked probability score (CRPS) of 850 hPa temperature at day 6 in the northern extratropics (30-day running means)

So far, the loss of aircraft data due to Covid-19, has not had a major impact on the scores

Metview's Python interface

https://confluence.ecmwf.int/metview

- Available on ECMWF platforms including ecgate
- Install Metview on Linux and macOS via conda and pip:
  - `conda install metview -c conda-forge`
  - `pip install metview`
- Source available for self-build
- Gallery of examples, Jupyter notebooks
- Training material
- Webinars



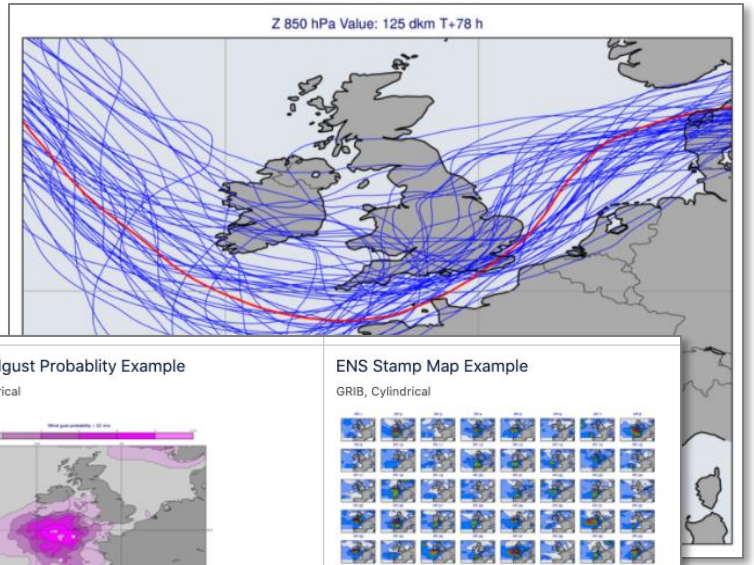

```
In [11]:

t2m_gpt = mv.obsfilter(
    data = obs_3day,
    parameter = 'airTemperatureAt2M',
    output = 'geopoints'
)
```

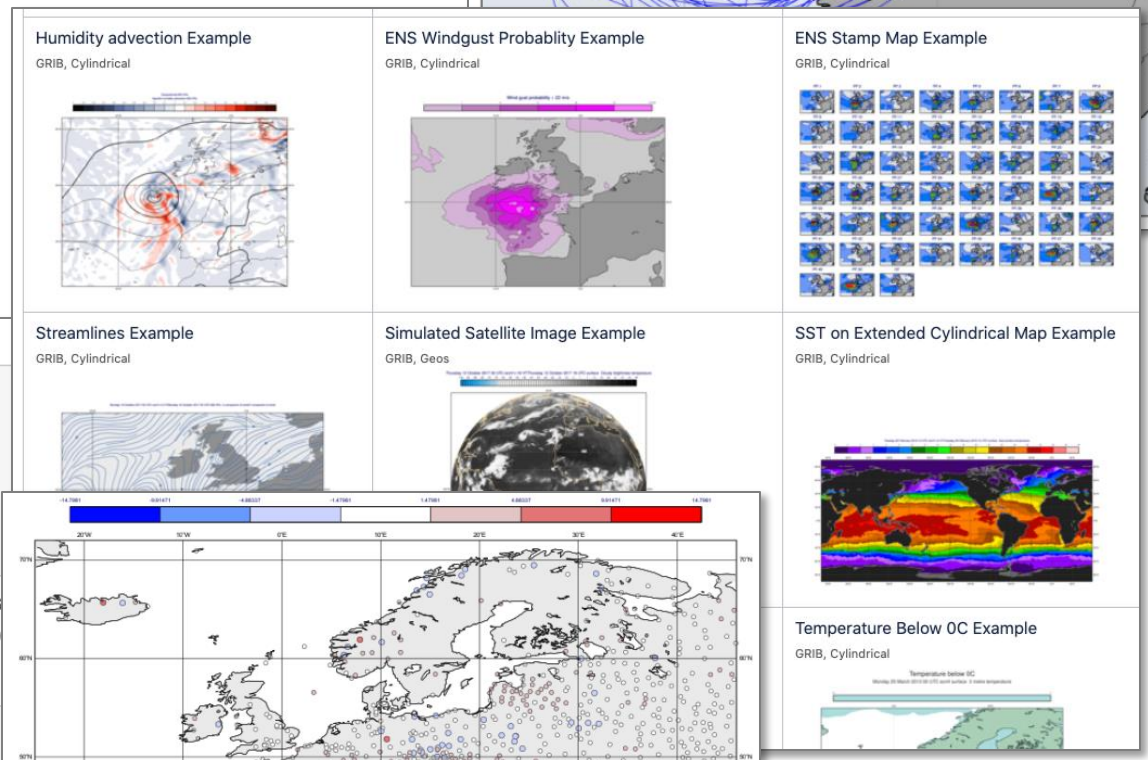
Computing the difference between the gridded field and the sc
compute the interpolated value from the field at that location, p

```
In [12]:

diff = t2m_grib - t2m_gpt
```

We can then use Magics' powerful symbol plotting routine to as

```
In [13]:

max_diff = mv.maxvalue(mv.abs(diff))
```

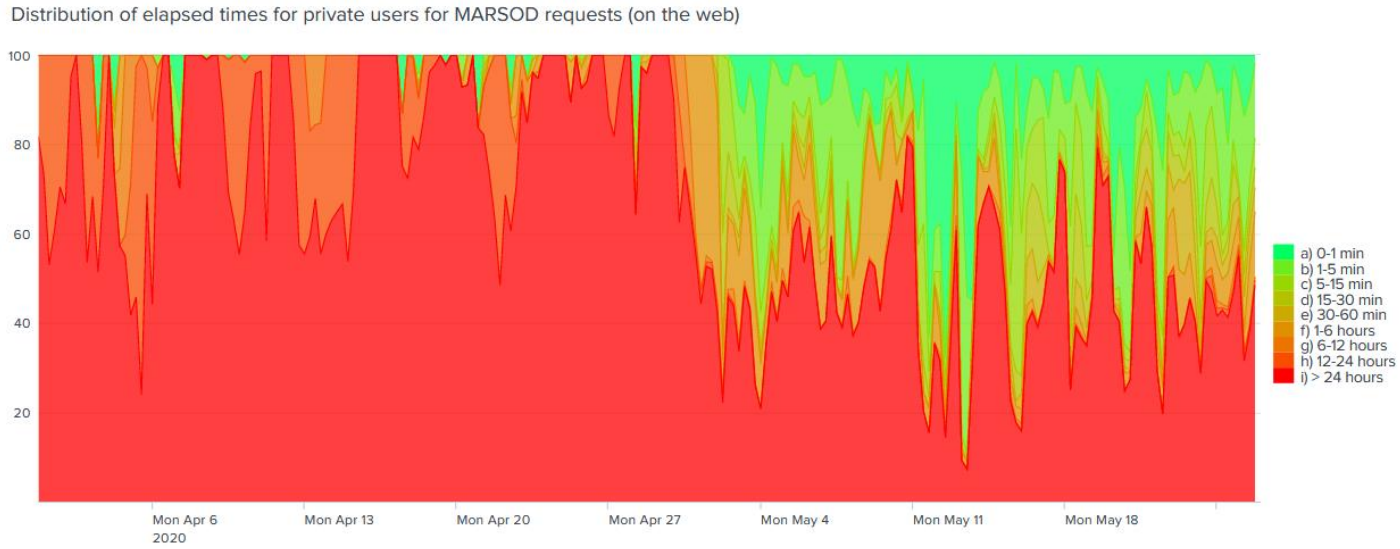


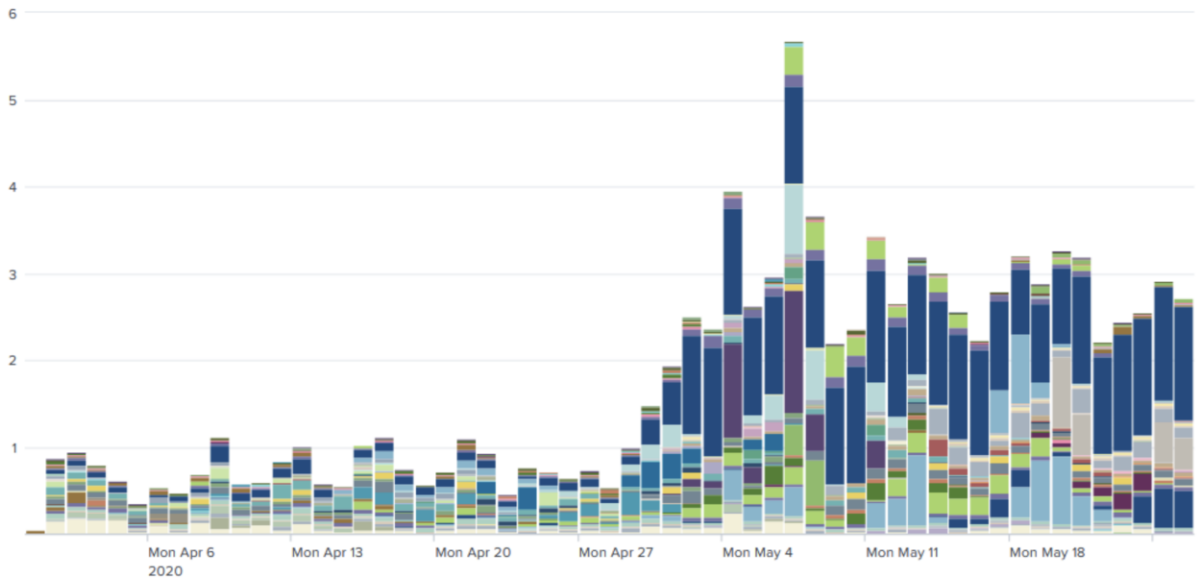


For plotting you need data ….

Services for users - data

- On 29 April 2020 a new setup for web access to the MARS access was implemented
- WebAPI service has been split into a public interface and a private one
  - ‘private’ for registered users from Member States and commercial customers
- Change was transparent to users
- Time it takes to process requests from private users is much improved
- Increased throughput for private users from an average daily 0.5 TB to an average of 2.5 TB

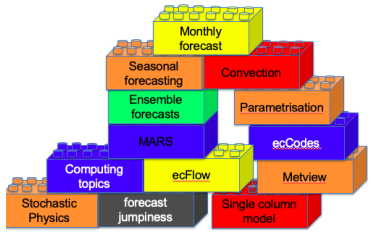


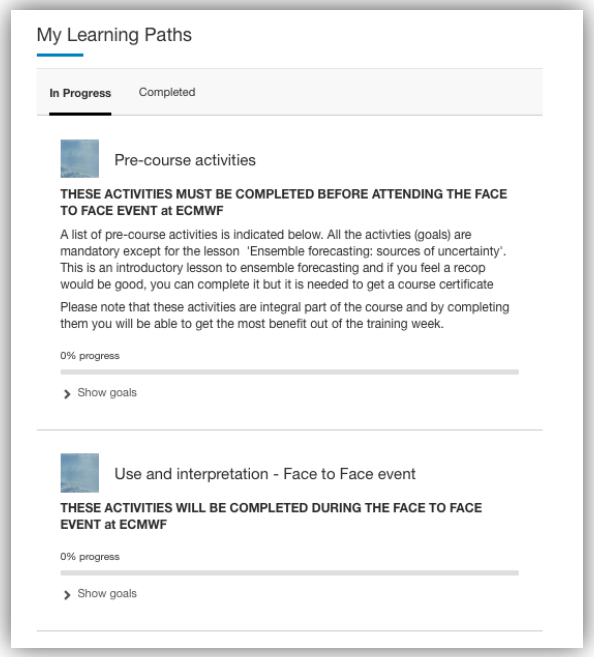


Delivered volume (TB) per private users

Services for users - Learning

What we have done so far ….





Blended learning

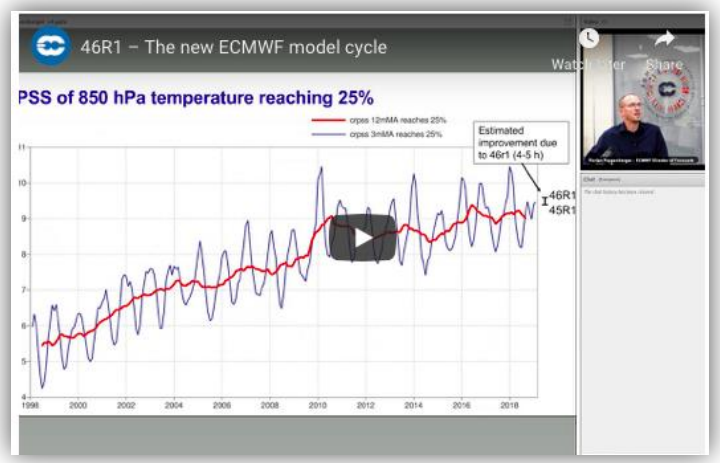
- Produce bite size online learning
- Staged introduction of blended learning
- Case studies and practical activities (tutorial like for software and NWP and real weather events case studies)

Centralize training resources

- Introduced a new Learning management system from which learning will be consumed

Increased the number of webinars

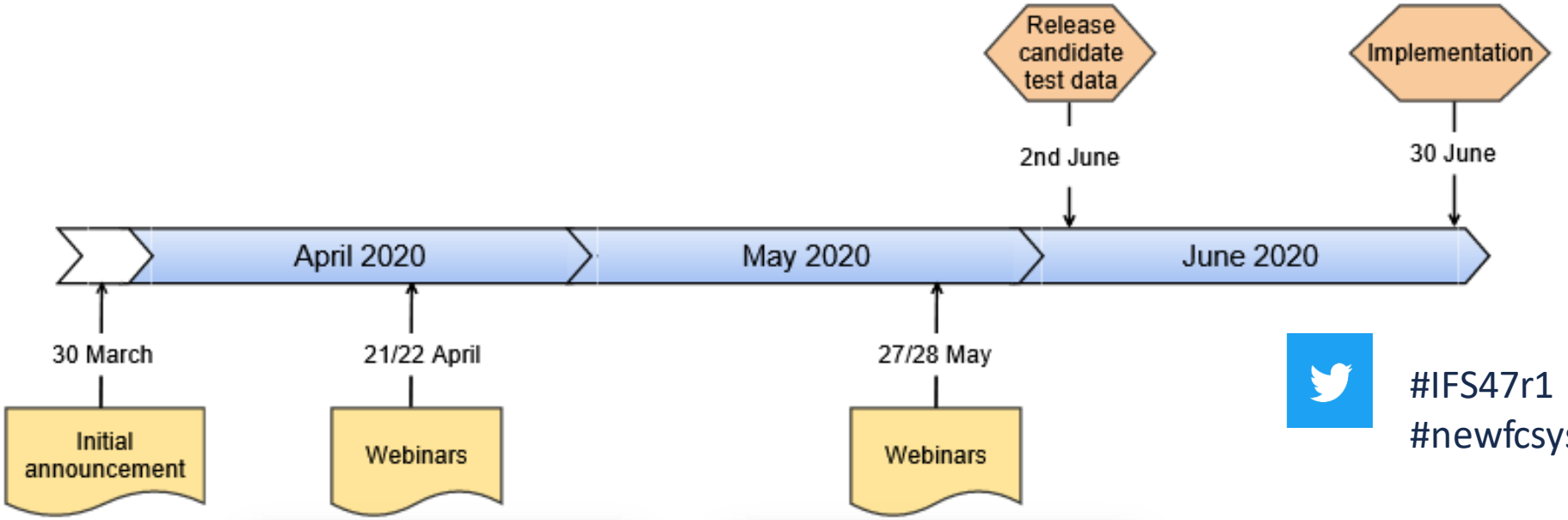
- New model cycle
- Observations
- Software/visualization (online learning week in May 2020)



Hands-on Introduction to NWP models

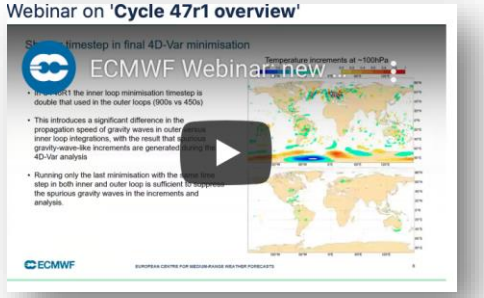
- A pilot in 2019 and a full 4-day course in 2020 based around OpenIFS with an additional drop-in clinic day to “ask the expert” ***(postponed!)***

ECMWF new forecast system cycle 47r1 - Implementation timeline



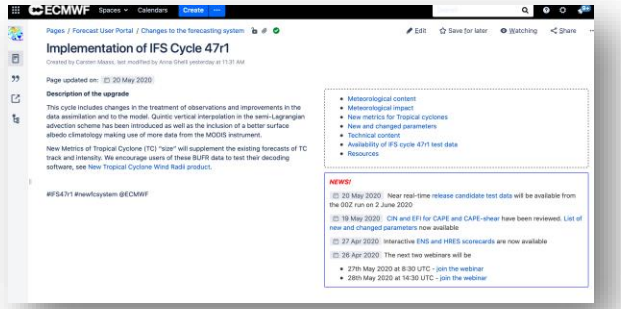
#IFS47r1
#newfcsystem @ECMWF

Webinar on '**Cycle 47r1 overview**'

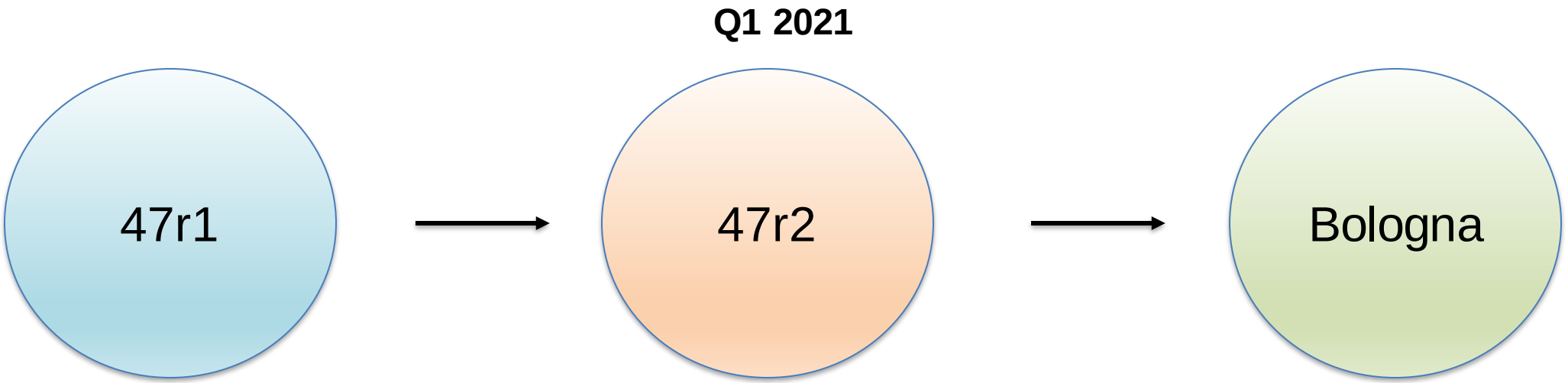


Webinar on '**Cycle 47r1 performance and products**'

https://confluence.ecmwf.int/display/FCST/Implementation+of+IFS+Cycle+47r1



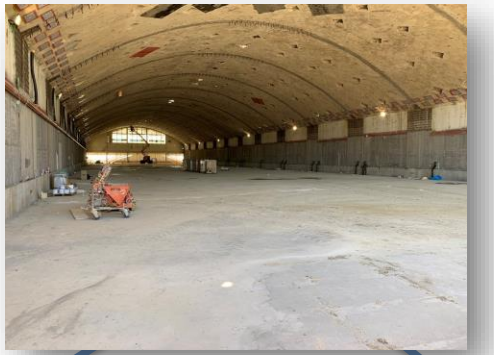
……. before Bologna …….



- *Single precision*
- *Ensemble vertical resolution: L137*
  (Ens resolution == Hres resolution)

BOND
Bologna Our New Data-centre

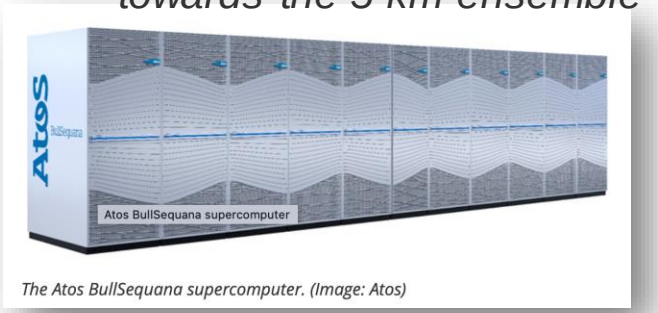
BOND is not just about our new premises……..



… it is also about our new HPC….

Benefits:

- *Improve ensemble forecasting*
- *continue investigative work towards the 5 km ensemble*



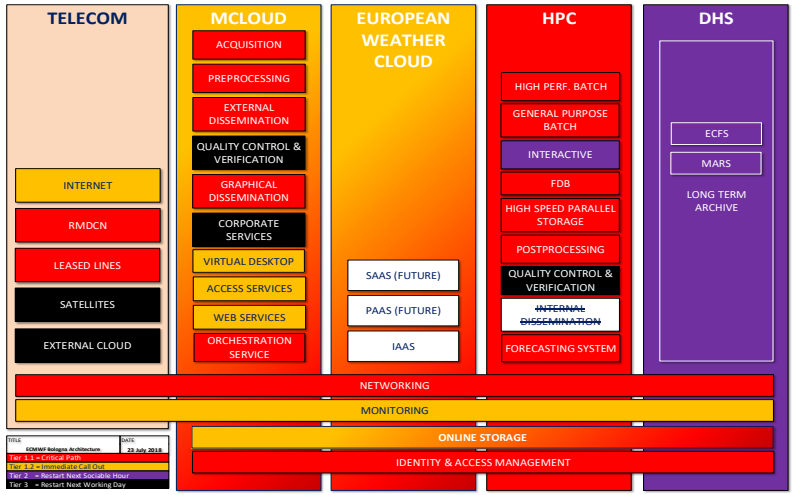
The Atos BullSequana supercomputer. (Image: Atos)

… and a new model upgrade….

The first new scientific cycle to run on the Bologna HPC will be 48r1, which will be a major upgrade of the horizontal resolution of ENS into the range 9-11 km. Other major changes intended for this cycle include the implementation of an improved, consistent moist physics framework. No change to High resolution.

… and a different and innovative way to improve our services

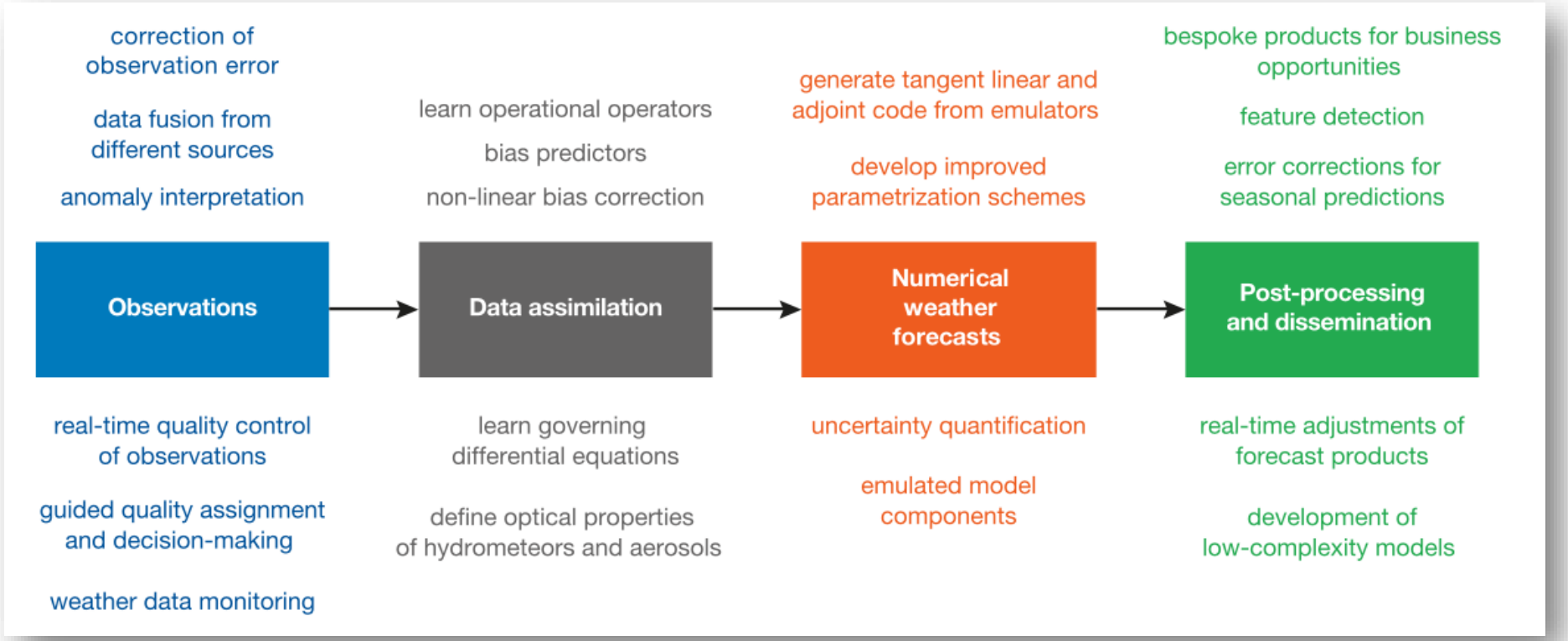
New infrastructure and design, new HPC, new tape archive; with cloud computing and AI as important components for the future – all in the proximity of EuroHPC pre-exascale system



Operational Q3/4 2021

Artificial Intelligence and Machine Learning at ECMWF

ECMWF is currently making a significant effort to support applications of artificial intelligence and machine learning and to identify how such applications may improve numerical weather prediction at the Centre.



New seminar series on machine learning started in April 2020:
https://www.ecmwf.int/en/learning/workshops/machine-learning-seminar-series

ESoWC – Innovation programme

Stream 1*

Stream 1: Weather-related software and applications

Stream 2*

Stream 2: Machine Learning and Artificial Intelligence

Stream 3**

Stream 3: Cloud-based weather and climate innovations

CODING PERIOD

*The 4-month long coding period started on 4 May 2020 and lasts until 31 August 2020. During this time, the selected teams team up with experienced mentors and experts in weather, climate, machine-learning and cloud-computing. Follow the progress of the projects on **GitHub***

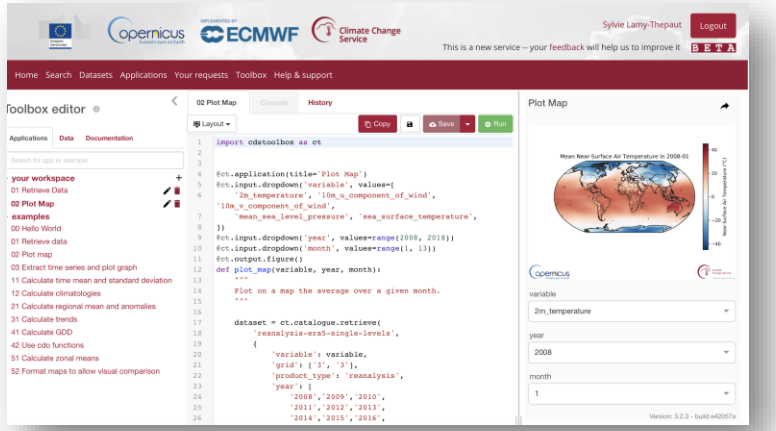
Copernicus activities

Climate Change Service
climate.copernicus.eu

Atmosphere Monitoring Service

Emergency Management

*ECMWF: entrusted entity for **C3S***
*ECMWF: entrusted entity for **CAMS***



https://cds.climate.copernicus.eu

https://ads.atmosphere.copernicus.eu

ECMWF: Contractor to JRC for operating:
CEMS-EWS (Flood)
CEMS-EWS (Fire)

Florian Pappenberger

Director of Forecasts

@FPappenberger

THANK YOU